Investigating the effect of color on memorization and trust in e-learning

ABSTRACT

The objective of this paper is to study the effect of the color of e-learning platforms as an atmospheric variable of the interface on the learning process. It focuses on two important variables, memorization and trust. First, it aims to explore the effect of color on the memorization of the educational content available in an e-learning platform. It investigates if the colored appearance of an e-learning system reinforces readability, suitability, and above all the memorizing process leading to learning. Second it investigates the effect of color on trust in an e-learning platform and in the e-learning content. The paper offers an examination of the role of the interface and the color in e-learning and memorization and presents trust in e-learning based on an exploratory qualitative study on how trust is developed in a website, as a result of the colors of the online interface. A case of an e-learning platform has been investigated to understand how the colors of the interface can enhance student memorization of the content as well as trust.

Keywords

Color, e-learning, ergonomics, memorization, interfaces, trust

1. INTRODUCTION

E-learning enhances the speed of training people, drastically reducing costs for educational institutions and businesses facing an increasing need to train people rapidly. E-learning often relies on the goodwill of some teachers or practical approaches of companies specialized in e-learning. A growing body of literature has studied e-learning with several studies focusing on principles for e-learning design and implementation (Scott, Shurville, Maclean *et al.*, 2007; Ettinger, Holton and Blass, 2006; Siqueira, Braz and Melo, 2007). Based on 29 research case studies of organizations implementing e-learning projects, Ettinger et al. (2006) present key areas that should be taken into consideration. These studies point out that quality content and user-friendly technology needs to be carefully chosen, as they are even more important than for traditional learning. Among the various issues that are associated with e-learning, the interface is of primary importance. As mentioned by Weinreich *et al.* (2006), a breakdown of page characteristics shows that users often do not take the time to read the available text or consider all links. An e-learning platform cannot suffer from this type of problem, since learners have to trust a system where the information is neither hidden nor difficult to identify. The latest can be partly solved by a professional use of colors, (a) of text and hyperlinks (foreground color) and (b) of background.

The web interface is the portion of the website that is visible to the web user (Dailey, 2004). In parallel, drawing from Kotler's (1973) definition of brick and mortar atmospherics, web atmospherics can be defined as the conscious design of web environments to create positive effects in users (e.g., positive affect, positive cognitions, etc.) in order to increase favorable

responses (e.g., site revisiting, browsing, etc.) (Dailey, 2004). An important user behavioral response to a stimulus such as a course presented on an e-learning platform to learners, can be the memorization of educational content. Drawing from previous studies in e-commerce (Pelet, 2008, 2010b), the atmospherics of the e-learning interface can arguably have an important effect on memorization. However, with regard to research dealing with an element of the interface appearance, such as color, we have little information about the role in the process of memorization of e-learning content. Limited studies refer to this topic, and empirical studies dealing with the effect of interface consistency or inconsistency on learning processes for e-learning remain still quite rare.

With the large amount of information presented on e-learning websites, memorization becomes an important factor for online learning since studies are facilitated when the learner can retain information from one page to the next. This implies that memorization of information in an e-learning website may have an impact on learners ability to digest and understand the subject matter and may allow consequently for success at their exams. This can potentially be facilitated by the website colors. However, the relationship between memorization and learning online has not been investigated. In addition, there is a lack of research regarding color and its effect on memorization and learning in e-learning websites. Hence, the education industry would probably find interesting results linking color, memorization and trust, since e-learning is close to e-commerce in terms of looking for and retaining information from a screen. Results from a previous research on the effects of color have proven how important this attribute of the interface was for the perception of time for example. Gorn *et al.*, (2004) focusing on the impact of the three color components on downloading time perception demonstrate that a lengthy waiting time influences the user's appraisal of the web site and can lessen his/her desire to recommend it to others. The same could be evocated in a learning context, since learners increasingly go for "quick to acquire embrace" content.

This chapter investigates the effect of the color component on the memorization of online educational content and trust. As Tricot and Plégat-Soutjis, (2003) point out the visual use of a device such as the computer screen is only effective if it is perfectly consistent with the entire device. The user behaves with what he recognizes to make sense with the e-learning platform. This is the principle of affordance proposed by Gibson (1977), which corresponds to the suggestive capacity of action for an object, a button or a form. Affordance theory states that the world is perceived not only in terms of object shapes and spatial relationships but also in terms of object possibilities for action - perception drives action (Gibson, 1977). This is the reason why measuring the content of the information stored by respondents seems interesting. It serves to make assumptions regarding the learners' perception of the color appearance of the used e-learning platform since what a learner memorizes depends on what he understands according to the e-learning platform interface and its variables such as colors.

Following Rhee et al.work (2005), who studied the question of the effect of consistency of interface on learning and the potential differences between groups of students skilled in computers versus novice students, our aim is also to investigate the effect of the colors of an e-learning interface on user trust. We posit that the colors of an e-learning environment can influence user perceptions regarding the trustworthiness of the e-learning platform, the educational content as well as the actors involved in the e-learning process. Our findings could

provide both researchers and practitioners with new criteria for color contrast design issues in the era of e-learning.

As a first step, we review the factors aiding the memorization of the educational content discussed in the literature. We will then investigate the research issues related to the effects of the colors of websites that could improve our understanding in the field of e-learning. The paper then presents the concept of trust by linking it to e-learning and how it can be influenced by the use of colors. The link between online trust and color is further examined with a qualitative study that is presented next. The study continues by providing an exploration of the effect of color on memorization and trust of e-learning users using a case study of an e-learning platform and brief conclusions end our paper.

2. E-LEARNING INTERFACE

E-learning platforms are information systems are increasingly used in organizations in the business as well as the educational sector (Pelet, 2010a). Most of the users of such platforms are known as *lifelong learners* as the skills they acquire mean that they are continuously challenged and search for information (Reisman, 2003, 240). Some of these *lifelong learners* can also be gamersplayers. Literature suggests that 3-D virtual worlds such as Second-Life can be well suited for experiential learning environments (Jarmon & al., 2009). This looks like a new approach of e-learning.

Literature in the area of e-learning points out that the quality of educational software is significantly related to its interface quality (e.g. Buzhardt *et al.*, 2005; Cantoni *et al.*, 2004; Chu and Chan, 1998; Hinostroza and Mellar, 2001). Regardless of the technical type of the platform, desktop software or internet website, the interface remains equally problematic, dealing with the behaviour of the user, depending on its perception of the latest. The interface quality of educational software or websites, moreover, has a serious impact on the learning outcome of the student (Gauss and Urbas, 2003; Jonassen and Wang, 1993). Crowther *et al.* (2004) argue that the impact of a poor interface design in education is more serious than in business. It impairs a student's overall motivation, as well as their learning performance, and has serious moral and ethical implications. In essence, interactivity between student and interface has been considered as the most important aspect in several studies on how to improve quality of education through e-learning (Cantoni *et al.*, 2004; Chou, 2003; Ellis and Blashki, 2004; Gauss and Urbas, 2003). According to interface consistency theory, which deals with the interaction between the user and the interface, increasing the consistency levels of interface results in a significant decrease of error rates in computer and web-based tasks (Ozok and Salvendy, 2004).

On an e-learning platform, the learner views various web pages, which use different features such as color, animation, sound, text, animations, photos, textures, and graphics in order to draw the learner attention. Among the range of visual factors that define the web interface, color can be deemed to be of high importance. The interface is made of components which affect the visual and auditory ability to stimulate the senses of the learner, in order to perceive its emotional, cognitive, psychological, physiological and behavioural functions through their changes. This is even verified referring to the psycho-environmental model from Mehrabian and Russel (1974), also called Stimuli-Organism-Response (SOR) model.

Before succeeding scoring on an e-learning platform, learners need to read and memorize. Students in an e-learning course have to analyze and synthesize the information they read on e-learning websites. But they also have to memorize where this information was, and how to reach it quickly for getting results they want efficiently. They also have to memorize it if they want to fill a questionnaire. This is why memorization is so important for e-learning objectives, as a part of the entire process of learning online.

Literature on the development of computer-assisted courses has provided for a long time inquiries on the use of text, color and graphics (Aspillaga, 1991, Livingston, 1991; Rubens and Krull, 1985; Soulier, 1988; Steinberg, 1991; Szabo and Poohkay, 1994). The most important difficulty in the development of such courses is to facilitate learning as much as possible in order to reduce the external cognitive load which is associated to the use of the tool and to the type of presentation in order to benefit to the intrinsic cognitive load related to acquiring content (Sweller, 1999). For this reason many techniques, combining for example graphics, images, videos and sounds, must be developed in this direction in order to optimize the storage capacity of the learner. It was shown that the learner memorized more content if both memory channels, audio and visual, were prompted at the same time (Mayer 2001, Mayer and Gallini, 1990, Clark and Paivio, 1991, Ando and Ueno, 2008).

The visual channel refers to the reading and retention of content on an e-learning platform. Readability represents the reaction time required to find a target word when searching in a website (Hall and Hanna, 2004). Readability is rather informative in this stage with respect to basic processing, it does not address outcomes such as retention, which is based on the cognitive architecture. The term “cognitive architecture” refers to the manner in which cognitive structures are organized. The two most important of those aspects of human cognitive architecture relevant to visually based instructional design and around which there is broad agreement are the working memory and the long term memory (Sweller, 2002). While considerable work has been carried to the organization of human cognitive architecture (Sweller, 2002), far less effort has gone into investigating the memorization of the information presented on e-learning platforms. De Groot’s (1965) work on chess (first published in 1946) demonstrated the critical importance of long-term memory to higher cognitive functioning. He showed that memory of board configurations taken from real games was critical to the performance of chess masters who were capable of visualising enormous numbers of board configuration. The skills depended on schemas held in long-term memory, thanks to the retention of information.

Retention is a very important factor for a learner facing a large number of information on the websites he/she must visit before answering to questions and pass courses. It is an important factor for e-learning applications, since the user’s goal is usually to retain the information beyond the time the page is being read: in order to score at exams based on reading and retention of information permitting to answer to questionnaires, memorization appears as the main way to score on e-learning courses. Thus, measures of higher level processing, such as retention remains an important topic in examining the effects of text-background color combinations, for the success of e-learning websites.

3. EFFECT OF COLOR ON E-LEARNING

Studies have shown that 80% of the information processed by the brain of the Internet user comes from the sense of sight (Mattelart, 1996). This implies that the visual function of the learner is a key factor for e-learning. The visual function is linked to light, color, and various other dimensions. This visual function is important to consider since it has already been established that human beings appeared to be exceptionally sensitive to visual learning (Kobayashi, 1986) and that any use of visual content could enhance its acquisition. On the contrary, over-cognitive load associated with excessive use of graphical means do not seem to be productive. Indeed, research has shown that if learners are sensitive to fixed or animated images, this is even more true if these images facilitate navigation without overloading its access or its clarity (Wright et al, 2000). This is especially important for schools or educational institutions interested in embracing e-learning. Color and typeface are two important characteristics of visual stimuli that may affect visual performance (Shieh et al. 1997). Color can be an effective means to improve human-computer communication (Pastoor, 1990; Silverstein, 1987). Color is also commonly expected to provide an additional subjective benefit by making work seem more pleasant and trustworthy.

Although color is widely researched topic (Divard and Urien, 2001), to this day there is a lack of studies focusing on color in the online context. Color in websites has been studied within information systems, especially in human-computer interaction, usability and e-commerce, recognized as a fundamental aspect in web interface design (Lee and Koubek, 2010; Wu *et al.*, 2008; Coursaris *et al.*, 2008; Kang and Corbitt, 2001). Research has found color to be an important factor in e-commerce, influencing website aesthetics (Agarwal and Hedge, 2008; Coursaris *et al.*, 2008; Schmidt and Liu, 2005) e-retailer perceptions (Agarwal and Hedge, 2008), user preference for e-commerce web sites (Lee and Koubek, 2010). With the interaction with the system, as well as the aesthetics of the interface being also of similar importance in the context of e-learning, it can be assumed that these works can imply a link between color and memorization and trust in e-learning,

Color is one of the components that take part in the physical consistency (Rhee et al. 2005). The physical consistency is part of the interface consistency of the e-learning platform. The latest is also composed of communicational and conceptual consistency.

- Physical consistency is the consistency of the graphical appearance or the visual characteristics of an interface feature;
- Communicational consistency is the consistency of the input and the output of the interface;
- Conceptual consistency is the consistency of metaphor applied to an interface feature or an action that is embodied within a feature.

Among the modes of visual recognition of the human being, color is at the origin of a significant number of work on the acquisition of knowledge, allowing to improve the development of printed materials (Moore and Dwyer, 1997). For example, we know that the structure of the text will affect the memorising of some part of it (Kintsch 1970, Meyer 1975, Meyer et al, 1980). Color allows the learner to distinguish the learning object (Gibson, 1966). It is also a major paralinguistic organizer, which means that a presentation can be graphical or temporal and allows presenting the displayed information in a structured manner. This effect is even more

strengthened when it is associated with a color that allows either to focus on some of the text, or to categorize the information (Dwyer and Lamberski, 1982-83). The color should also be used as a learning strategy. The choice of colors used to raise specific issues or to prioritize the importance of information to be integrated into the thinking at the design stage is thus very important to take into consideration. This is to limit the potential risk of overloading. The concepts of learning and memory are thus directly related since the content of e-learning platforms and the colors used are key factors for the readability of information.

The graphic of the e-learning platform website, which represents the whole graphical presentation, contains basically two colors: the foreground color, also called tonic or dynamic color by webmasters, and the background color, which is the dominant one. This association reveals the contrast, which corresponds to a strong difference between a foreground and a background color, as defined by the W3C (Accessiweb, 2008). Its main function is to enhance the readability of the displayed information, and a fortiori the memorization and the fact of passing the examination in the case of an e-learning platform. It seems therefore interesting to know what information is stored and what can be the successful completion of an examination related to a previously learned content through such a platform.

In any case, research about the impact of color on the effectiveness of online learning does not concern the use of color that much for an entire text, although the use of black text on white backgrounds seem preferred to transfer knowledge (Hall and Hanna, 2004). As part of an experiment the purpose of which was to measure how much and what quality of information was retained by the consumer when he visited an e-commerce website, interesting results have emerged. They show that the memory score grows when colors of foreground and background are chromatic, i.e. different than black and white and their intermediate greys (Pelet, 2008). Interaction effects of hue and brightness operate on free recall, especially when background and foreground colors, i.e. green and yellow in the context of the evocated experimentation, are used.

Memorization is a very important factor for the large number of information-based websites that currently exist. It is important for e-learning applications, since the user goal is usually to retain the information beyond the time the page is being read. In order to understand the effects of color on consumer memorization we have to take into account the quality and quantity of information a user has memorized while visiting an e-learning website. We posit that memorization varies according to the colors of the website, and especially according to the contrast between the dominant and dynamic colors, in agreement with the work of Hall & Hanna (2004). In general, information is stored according to an encoding process enabling one to sort out information thanks to criteria which will then allow one to retrieve this information. The role of these criteria is to connect a piece of information to other similar information already stored (Ladwein, 1999).

4. E-LEARNING AND TRUST

Trust has traditionally been a complex, multidimensional and context-specific phenomenon (Lewis and Weigert, 1985; Butler, 1991; Barber, 1983). It has been the topic of numerous research studies in various disciplines, including psychology, sociology, economics and marketing. It has long been identified as a key factor in any kind of relationship and has been

shown to be of particular importance in traditional as well as in electronic settings, such as e-commerce (Gefen *et al.*, 2003; Papadopoulou, 2007).

As is evidenced in the literature, trust is characterized by a lack of consensus regarding its definition. It is a multi-faceted concept, resulting in a collection of multiple, diverse definitions of trust, which is evidenced across all disciplines where trust has been studied. Divided in two dominant conceptualizations, trust is viewed by many as a belief or expectation implying a notion of confidence and trustworthiness stemming from the partner's expertise, reliability, or intentions (Blau, 1964; Pruitt, 1981). Under this stream of research, the concept of trust has also been widely studied under the notion of beliefs about trust relevant attributes of the trustee, largely referring to the perceived benevolence, competence, integrity and predictability of the trustee (McKnight *et al.*, 1998). From another perspective, trust is seen as a behavioral intention or willingness to be vulnerable and rely on another party, accepting the risk and uncertainty emanating from the assumption that the party will behave within accepted norms (Williamson, 1975; Coleman, 1990; Deutsch, 1960). Researchers adopting this view have separated beliefs from trust conceptualizations and defined them as antecedents of trust (Mayer *et al.*, 1995). While discriminating between beliefs and behavioral intention, a third research stream has argued that both are necessary components of trust (Moorman *et al.*, 1992; McAllister, 1995; McKnight *et al.*, 1998).

Trust is an important factor in the decision of people when they choose others with whom to interact (McKnight *et al.* 1998, Zaheer *et al.* 1998). In the case of an e-learning platform, the learner, in order to use it, decides if the interface can be trusted or not or if the lecturer can be trusted or not depending on whether the content displayed on the screen is acceptable for him. Several factors may explain why high initial levels of trusting beliefs and intentions might be observed (Stewart, 2003). These include individuals' disposition to trust (Rotter, 1967), the existence of assurance mechanisms (Zucker, 1986), security felt in the situation in which the trust target is encountered (Lewis and Weigart, 1985), calculations regarding the incentives and penalties to the target of acting in a trustworthy manner (Lewicki and Bunker, 1996), and cognitive processes such as stereotyping and categorization (McKnight *et al.*, 1998).

Trust has recently been identified as being an important parameter in e-learning. Anwar and Greer (2008) characterise trust as a cornerstone of safe and engaging e-learning environment. Orton-Johnson (2009) has shown a high tendency of students not to use e-learning material attributing it to their trust in traditional texts as authentic academic knowledge and an instrumental and strategic approach to study. Arguably, in the context of e-learning, trust can be an important variable for e-learner behavior. As e-learning involves the use of an electronic, usually online, means, it changes the learning process and creates new challenges, with trust being one of them.

Trust in the context of e-learning can include several aspects that affect the success of an e-learning system. In order to effectively adopt and use an e-learning system, users should have trust in the e-learning system or platform. This refers to the interface and the characteristics offered by the platform. In addition, users should have trust in the content provided in the e-learning platform. This trust aspect is very important for e-learning since if users do not believe that the content of an e-learning system is reliable and trustworthy, they will not use the e-

learning system or they will not exploit its advantages to a maximum. Trust is also related to the actors involved in the e-learning platform, i.e. students, educators, moderators/administrators, content providers. The trust of the users of an e-learning system may vary among the actors according to their role and their content provision. For instance, students of an e-learning platform may have more trust in the content provided by an educator than in the content provided by other students.

Color, as an important interface element, is expected to influence user perceptions regarding the trustworthiness of the e-learning system. A previous study has shown that trust was considered as an important variable to consider when accomplishing a research on the effects of color interfaces on users. In particular, color proved to be directly linked to the trustworthiness felt when facing an interface where the association of background and foreground colors reinforces readability and memorization of the content. Indeed, the contrast reinforces the buying intention when it is accurate (Pelet and Papadopoulou, 2010). In a similar vein, color can be associated with the trust that a user creates in an e-learning environment. The effect of color on trust can be attributed to the colors used as well as to the contrast of foreground and background colors. The colors, in terms of hue, saturation and brightness as well as the contrast can provide interface characteristics, such as ease-of-use, which can be perceived by the user as signals of trustworthiness. The colors used in an e-learning platform could affect user trust in the e-learning content, as well as trust in the educator/tutor of the platform or in other actors contributing content to the e-learning platform. In this direction, an investigation of the effect of color on trust perceptions of an e-learning user will facilitate our understanding regarding the effect of color on e-learning. This study will focus on trust in an e-learning system largely referring to trust in the content as well as the teacher of the e-learning platform.

5. THE EFFECT OF COLOR ON ONLINE TRUST: A QUALITATIVE STUDY

An exploratory qualitative study was conducted in order to understand the relationship between color and trust (Pelet and Papadopoulou, 2010). The objective of the study was to investigate how user trust in a website is influenced by the colors of the interface. The study was based on the literature and the former studies examining these websites. We wanted to understand what made the respondents feel that they could trust a website they already have used. Our data collection aimed at identifying and classifying the elements which referred to the trust felt by users during a website visit, as a result of the colors.

The study was conducted using semi-structured interviews with 21 persons, regular users and skilled ones, close to web designers in terms of use of the web. We asked interviewees to speak about past visits to websites of their choice. The interview guide was structured and open and allowed us to collect data related to the subjects experience in websites. We adopted a neutral attitude with regard to them so as not to influence them in the way they answered. Interviews were conducted using what interviewees recalled from their past visit on websites. To ensure that the respondents only used their memory to provide information about their browsing websites, it was not possible for them to look at a screen showing a website interface during the interview (Jallais, 2006). The reason for which we investigated the memory can be understood by the following example. When people learn in traditional or electronic classrooms by relying on what they stored in their brain regarding courses information (date, equation, theoretical concept, etc), they rely on what they memorized. Indeed, in everyday life there is no trigger helping learners

recall the content of an e-learning website they visited or compare it with another course. Most of the time, learners can not visit the e-learning website where they found relevant information while they walk in the street. In case they can try and compare courses information for example, they can only trust what they stored in their long term memory. It seemed therefore relevant to conduct our interviews by respecting the same conditions as real life ones.

The objectives of the qualitative study were pursued on the basis of the following questions:
- Is color one of the atmospheric elements of websites that is important for Internet users?
- Do Internet users feel particular emotions while using a website? If yes, does color affect the emotions of the users?
- Do Internet users trust a website thanks to the colors as a variable of the website atmosphere?
- Does a website's color affect user perceptions of a website? How is trust influenced?
- Does color affect users trust and perceptions about a website in a positive or in a negative way?

5.1. Respondents characteristics

The exploratory qualitative study took part in France with French respondents. A total of 21 subjects participated in the study, 43% of which were female. The age of the sample population ranged from 31 to 57 years old. The majority of the participants (15 persons) were regular Internet users, while 6 of them were webmasters. The representation of webmasters and regular users according to the users numbers used in the study is summarized in Table 1. The interviews were based on websites related to different activities according to the interviewed persons and their habits. Different websites related to everything about selling were also used for description since selling products and courses can be compared according to us. Websites dedicated to downloads for webmasters also came to the discussion with the interviewed webmasters, such as Flashloaded for example.

5.2. Data analysis

Data were analyzed following the different stages of content analysis suggested by Vernette and Giannelloni (1994). Interviews can be analyzed in multiple ways following the research objectives (Evrard, Pras and Roux, 2003), which in our case was to explore the importance of color in trust and in what ways it was important. The responses were coded and the preliminary readings (Bardin, 1996) allowed us to identify the items. A cluster by topic and frequency of appearance of the variables followed. We respected a certain number of stages in identifying the subjects and the useful semantic units, as in any content analysis. The qualitative data were analyzed with a table summarizing all the results of our respondents, where each construct was assigned a '1' value for every instance. For each respondent, we analyzed the interview and we extracted instances of trust that were mentioned and that were related to color. We then grouped the 'result' columns of all our respondents in the final table in order to understand precisely what the answers meant. This corresponded to a total of 22 columns, with cells having either a '1' value or being empty. Rows in this table indicated the different themes issued from the interview guide. Topics and words related to a precise field appeared in a 'result' column, showing the frequency of appearance of each construct. The results are summarized in Table 1.

Respondent No	Respondent expertise	Trust Color Effect
1	RU	rich website, interactivity, cold, austere, minimalism of the interface

2	RU	Reassuring, facilitate the link visibility, content is put to the fore, convenience of website, usability procures help
3	RU	delimitate zones, ergonomics (search engines), zones facilitate tracking, harmonious, ergonomics helps the user
4	W	fluid navigation, clear, playful, harmonious, playability to use the whole website
5	RU	delimitate zones, reassuring, sober, facilitate tracking of links, clarity of the presentation
6	RU	rapidity, communicate, practical, enlighten, fluidity of actions
7	W	feeling of speed, cold, beautiful, not practical website, high level of information aspect
8	RU	enhances the content, boring, clarity, beautiful, sober
9	RU	Vivid, speed, convivial, procure advice, help information is simple
10	RU	make dream, deceive, lack of trust, poor information, poverty of information deceives
11	RU	clarity, aggressive, conviviality, no respect of the consumer, violent colors aggress users
12	RU	trusted website, secure website, competence, feeling of speed, fluidity reassures
13	RU	absorbed, professionalism of the website, ergonomics, feeling to save time, information structure serves information content
14	W	pleasure, ease of use, practicality, ease of finding information, ease of use thanks to color contrasts
15	W	distrust, poverty of information, conviviality, cheap look, vivid colors don't enhance trust
16	RU	absorbed, give advice, feeling of saving time, reliability, conciseness of information helps the user
17	W	richness of information, deception, rapidity of finding information, indecision, too much information doesn't serve the website
18	RU	rapidity to find information, attractive prices, stress, boredom, simplicity and aesthetic aspect
19	W	lot of choice in the catalog, suspicious, practicality, beautiful, aesthetic, richness of information and right choice of color family
20	RU	indecision, sober, easy-to-learn website, fluidity of information, clear zones of explanations help users
21	RU	purchase without pressure, conviviality, complex way of buying, espionage, conviviality and simplicity

Table 1: Qualitative analysis results summary

This exploratory qualitative analysis enabled us to note that color was actually an integral part of the websites interfaces. A number of elements, presented in table 1, were revealed as important to user perceptions, as a result of the colors used. The elements, which appear essential to the interface due to the impact of color, can be mainly grouped into:

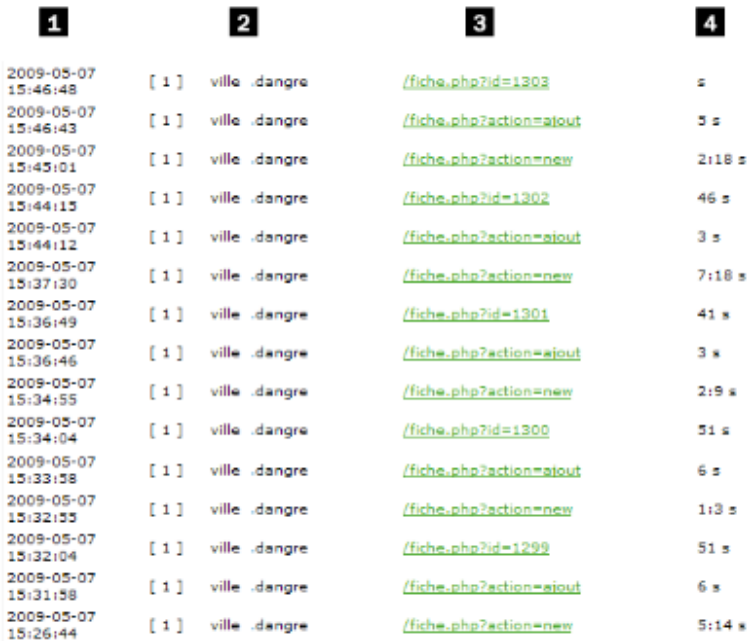
- elements related to usage - putting the organization of the site as a main factor, thanks to its clarity and the readability of its tree structure: this serves in favor of building trust
- elements allowing a rapid navigation within the site, by the provision of search engines in particular: this plays in favor of memorization since no time is wasted.

6. The case of Knowledge Management and Content Management System KMCMS

In this section we attempt to investigate how the interface of an e-learning environment and particularly the use of the colors can influence memorization and trust. A 6-years experience (between 2003 and 2009) using a knowledge management platform and content management system, is presented. Our description and pictures are extracted from an actually in use e-learning platform, Knowledge Management and Content Management System (KMCMS). KMCMS is an

online learning tool, in the form of a wiki, designed to help students to prepare their major projects in different courses. The wiki was built in 2003 and today, around 1500 contributions dedicated to very precise topics are available inn it. Project-related material, home works or major projects such as dissertations, has to be easily publishable and accessible for editing by any student logged on the platform. As time passes, more and more students publish their work (syntheses of academic papers, journalistic ones or reviews of literature on a particular topic) making it available for the overall community of students. The phenomenon is thus becoming autonomous since students get help from the contribution of other students, and also help the others to find easily what they could be interested in by working on it, adding their *"knowledge"*. One of the key factors of success of such a tool lies in the search engine mechanism that is embedded into the system to accelerate search and results found. This is one of our findings since any student working on this platform refers to this search engine first. As for any User Generated Content website, the role of the lecturer is to moderate each new contribution by asking the student to modify it if necessary.

This platform aims at sharing knowledge issued from reading papers (academic publications, student projects, books, managerial cases, etc), on a social network platform. The possibility to create pages with synthesis of academic readings or work experience projects, to communicate with other students or to present works from the platform to the wall of a room during "live" lessons, by using PowerPoint presentations for example, contributes to share this way of learning. The platform is therefore a powerful e-learning tool built on the restitution of readings from different levels (students, professors) and in different topics related to marketing, information systems and design themes, focusing on consumer behavior, ergonomics or usability on the Internet. These topics represent the main themes evocated by authors during lectures or across their academic publications. The same principles as those already used in the e-business industry are followed in the educational sector, with ratings and log files so as to understand the user behavior more precisely. Log files can show what content is read first, what page is the most popular and so on, exactly like a teacher does with an e-learning platform. (Figure 1):



1	2	3	4
2009-05-07 15:46:48	[1] ville .dangre	/fiche.php?id=1303	s
2009-05-07 15:46:43	[1] ville .dangre	/fiche.php?action=ajout	5 s
2009-05-07 15:45:01	[1] ville .dangre	/fiche.php?action=new	2:18 s
2009-05-07 15:44:15	[1] ville .dangre	/fiche.php?id=1302	46 s
2009-05-07 15:44:12	[1] ville .dangre	/fiche.php?action=ajout	3 s
2009-05-07 15:37:30	[1] ville .dangre	/fiche.php?action=new	7:18 s
2009-05-07 15:36:49	[1] ville .dangre	/fiche.php?id=1301	41 s
2009-05-07 15:36:46	[1] ville .dangre	/fiche.php?action=ajout	3 s
2009-05-07 15:34:55	[1] ville .dangre	/fiche.php?action=new	2:9 s
2009-05-07 15:34:04	[1] ville .dangre	/fiche.php?id=1300	51 s
2009-05-07 15:33:58	[1] ville .dangre	/fiche.php?action=ajout	6 s
2009-05-07 15:32:55	[1] ville .dangre	/fiche.php?action=new	1:3 s
2009-05-07 15:32:04	[1] ville .dangre	/fiche.php?id=1299	51 s
2009-05-07 15:31:58	[1] ville .dangre	/fiche.php?action=ajout	6 s
2009-05-07 15:26:44	[1] ville .dangre	/fiche.php?action=new	5:14 s

Legend:

1: date/hour the page has been viewed

2: name of the user (student in this case)

3: viewed page

4: time spent on the page

Figure 1: Log file from kmcms.net

6.1. Exploring memorization and trust

On the home page of this e-learning platform, students can easily see what is new about a lecture or a topic and what they have to do for their lesson. Once logged onto the e-learning platform, the trust of students in the e-learning platform increases thanks to the facility to view each lecture and the provided URL allowing to go to the page of a lesson, case or literature in one click. Colors of schools or Institution logotypes reinforce the feeling of trust that students need to have when logging on this type of website. (Figure 2)

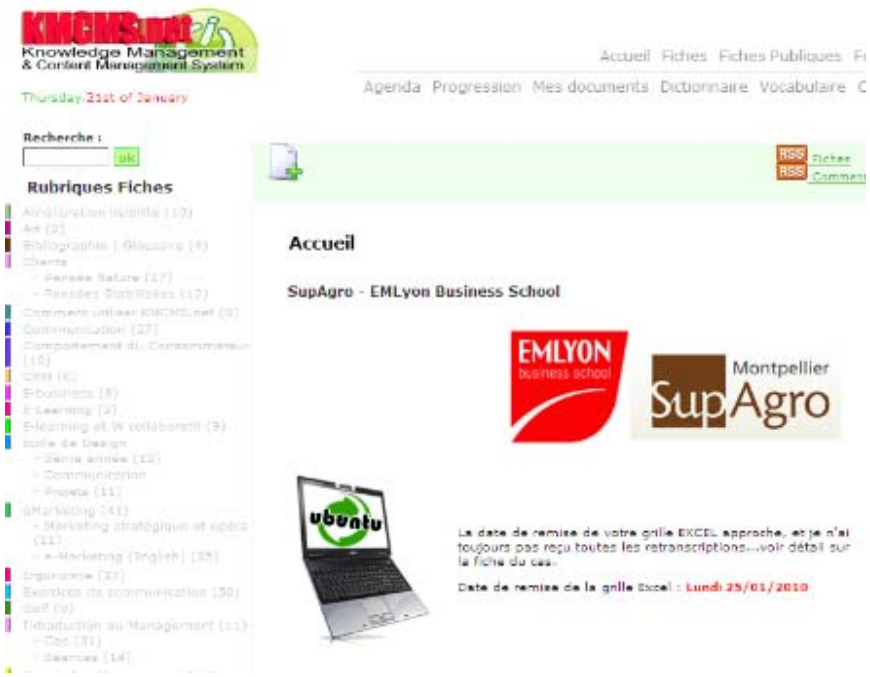


Figure 2: Homepage of the e-learning platform

Like on any e-learning platform, a search engine helps the student to look for any type of content. (Figure 3)

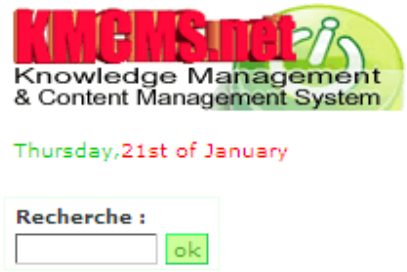


Figure 3: Search engine of the e-learning platform

After having typed their request, students can filter the search results by title, abstracts, keywords, authors, date of creation and content. In order to enhance the trust of the student in the results found, the word typed in the search engine is highlighted with a fluorescent yellow color on the results page. It helps the student to identify if the word comes from the title, abstract or any other part of the offered results. For example, when typing «color», in the search engine, 223 pages have been found in the database. As Maruyama and Akahori (2008) have shown, the use of color to highlight certain words in a text is effective in memorizing when one word only was highlighted. The first results appear on the pages as shown below (Figure 4):

Figure 4: Results of the search engine request appear thanks to a highlighted word

The possibility to ask for the "search in context" also exists; its function is to avoid for the student to open each page obtained among the results of the "results page". This feature can be very useful as it could indeed be dramatically long to check 223 pages to look for an information in this case. In this way, facilitating their search and reducing the time required for locating results, students trust as well as memorization are increased. The search engine offers answers containing the abstract, titles and keywords from pages of the databases. By providing paragraphs in the answer, containing the 200 characters before and the 200 characters after the word typed in the search engine, it is then unnecessary to open the page linked to the results page, since the student understands in which domain the typed word belongs to, in order to appear on the e-learning platform. The fact that there is no need to open unuseful pages enhances students trust towards the e-learning system. The system saves the students time, and enhances their trust in proceeding with their next request. It also reduces students effort to retaining the content found. Here is an example of the "*search in context*" result, when the word "humeurs" has been typed in the search engine (Figure 5):

Figure 5: Results in context save students time by showing the result pages without opening them

This e–learning platform is usable for old or low vision students. An option offers the possibility to enlarge and decrease the size of the fonts used on the e-learning platform. This is especially relevant when the student has to prepare a presentation and then present it in the classroom using a video transmitter. There is no need to bring the presentation on a USB stick, since it can be viewed directly from this platform and projected to a white board. It is simple to increase the size of the font by pressing several times on the links, dedicated to this functionality (A, a), and the presentation thus appears in a proper manner on the screen. (Figure 6).

There is also a possibility to change both the foreground (text) and background colors, by using a scroll bar that modifies the hue, brightness and saturation levels of both of them. This functionality improves the quality of the readability. The system appears to be particularly relevant for colorblind students (8% of males and 0,5% of females), studying in their proper conditions of colors when setting the colored appearance of the screen thanks to this

functionality. It therefore contributes in enhancing students memorization of the content as well as their trust in the e-learning platform. (Figure 6).

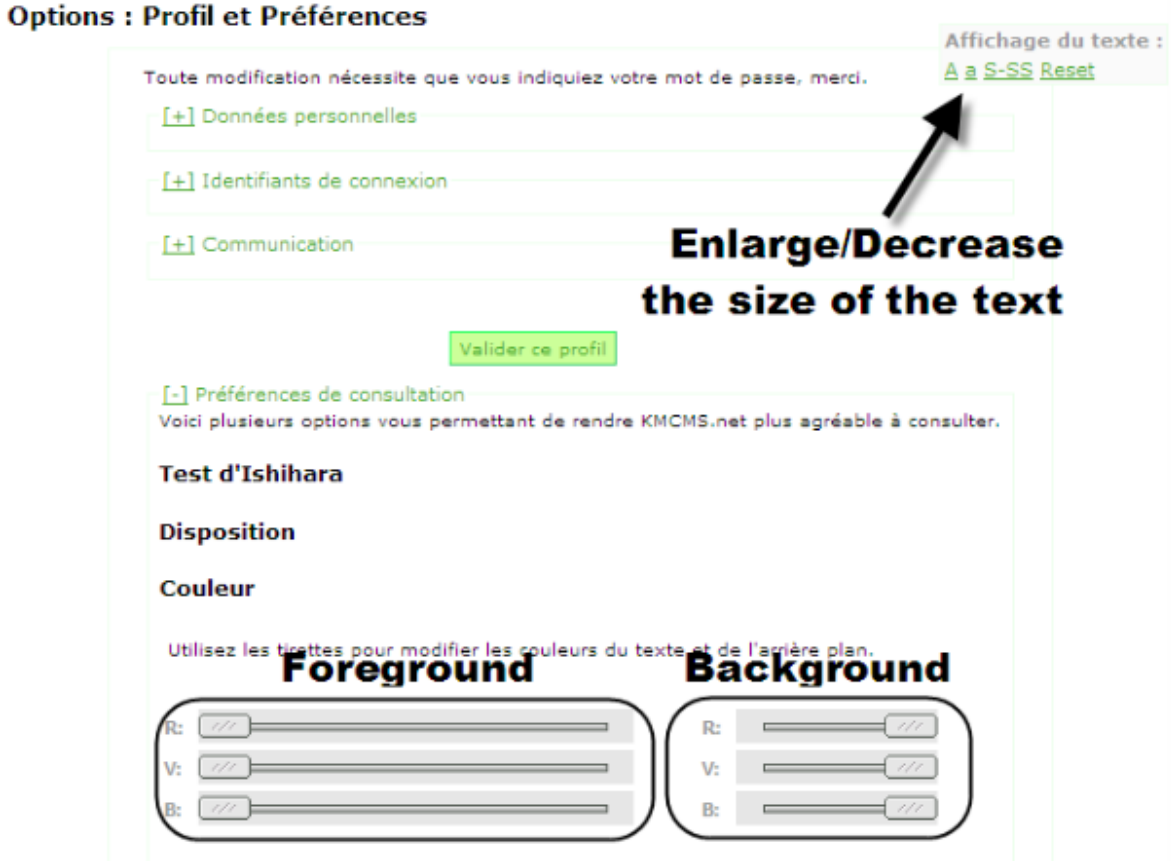


Figure 6: An e-learning platforms option allows to modify the size of the text, and the colors of both text and background

Here is an example of the platform after being modified on the color level (Figure 7):

Figure 7: Appearance of the e-learning platform once its colors have been modified

The customization of e-learning systems for computing novices appears like a way to bridge the gap in education equity according to Rhee, Moon and Choe (2005). The possibility offered to modify the aspect of the interface can also contribute to play in favor of the sustainable development since learners can use proper tools in this direction. Dark screens effectively participate to save the electric energy of the screen. Thereby, e-learning contributes to protect the environment by the use of a function aiming at modifying the colors of the interface by preserving a good readability to stay concentrated..

A vertical navigation bar is also provided as part of the KMCMS interface. The description of the possibilities offered is explained between the two images (Figures 8 & 9):

Figure 8: Each lecture owns its proper color, they reveal the different lectures that are available on the e-learning platforms at once

In the vertical navigation bar, each domain, lecture, field etc. corresponds to a proper color, enabling the students to look for a particular content more easily, by recognizing the color dedicated to it.

The figures into brackets provide information to the student: the number of pages available for the lecture/field etc. This is another way to enhance student memorization of content and trust towards the whole system.

One can notice that in order to make the content easier to read, the navigation bar uses a light grey font: a pale color making it discrete during an "unused period" (Figure 8), whereas once the cursors is on rollover, on the e-business section on Figure 9, the grey becomes darker. It is supposed to help the student to read the menu of the navigation bar more easily thanks to a better contrast.

Figure 9: On rollover, the vertical navigation bar has a bigger contrast to get a better readability

The same colors also appear when the student looks for content which is available on the platform. The domain of the content is then easier to recognize since the student approximately knows what he is looking for on the system. This can be even more relevant if he knows exactly which color corresponds to the lecture he has to read, learn and memorize. It is also another way to enhance his trust towards the system. It is noticeable that the number of pictures contained in each page is written in another color in order to provide information that can help the student, especially if he looks for particular content. (Figure 10)

Figure 10: Each page offers an aspect that is differentiated thanks to colors

When a page is opened, it offers a common visual aspect in order to help students know where the information is on the interface. The content of the box (n°1 in figure 11) uses the same background color as the title of the navigation bar already presented, and the same color of the course 'color'. This box - green on the following picture - always provides information such as:

- the date the page has been created,
- the domain it takes part of on the platform,
- the name(s) of the author(s) of the already read publication, in the case of a publication,
- the abstract of the page and the keywords chosen by the editor.

By preserving this consistency in the interface, the students are facilitated in memorizing the content and in trusting the platform.

A control bar (n°2 in figure n°11) is also placed on the right hand-side of the page, in order to facilitate the most repeated actions on the e-learning platform. This control bar will be described below. Finally, the content (n°3 in figure 11) always appear in a proper format making reading easy, thanks to the chosen font, length of each line, size of the underline, and of course, use of styles such as bold, italic, underline and colors, following ergonomics guidelines (Figure 11). All these characteristics and their combination are important for increasing students memorization of the content and also their trust in the e-learning system.

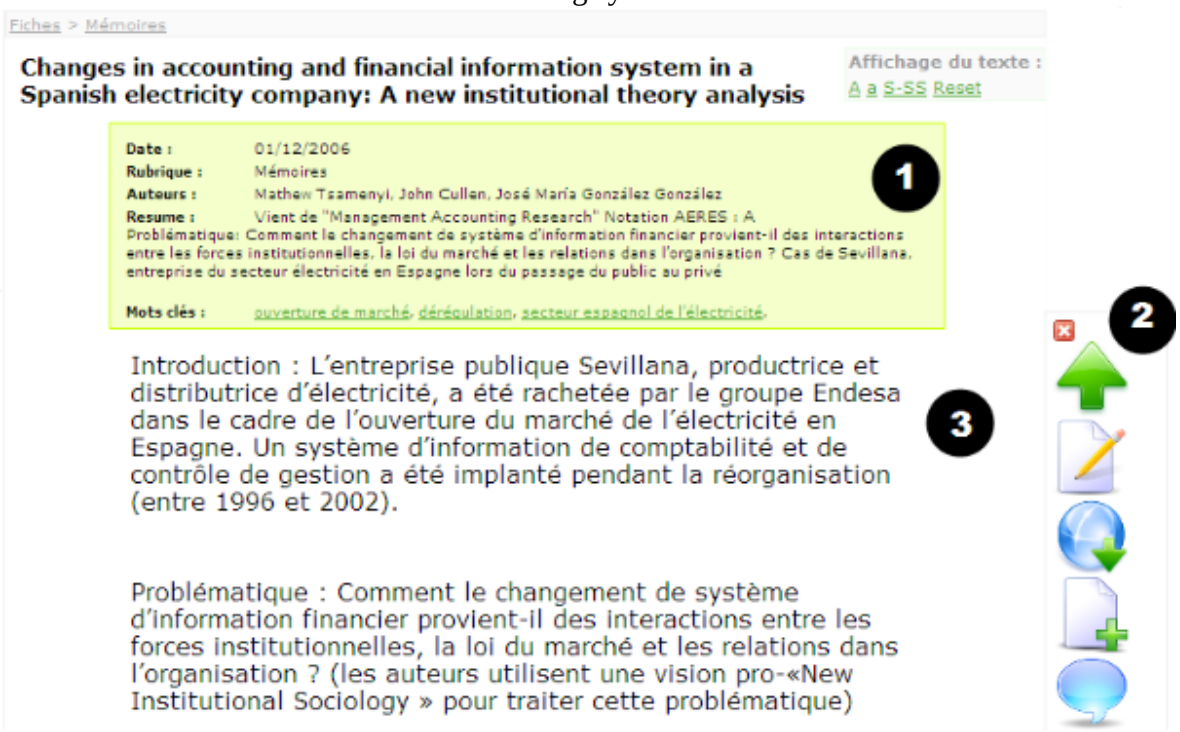
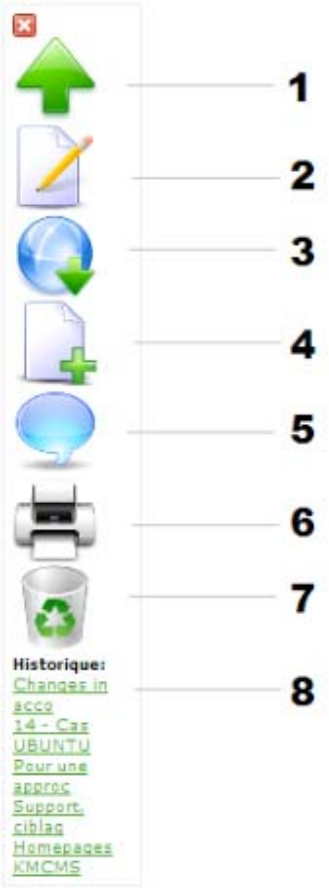


Figure 11: Each page has a common interface in order to facilitate the memorization of the content

The control bar appearing on each page of the e-learning platform is a tool which is particularly relevant when the time spent on the platform is important. Each button has effectively a proper role that will activate the navigation by making it more fluid. The control bar is very important for students trust and memorization, particularly in navigating and using the interface (Figure 12).



1: the **green arrow** is a *"super elevator"*, to quickly attain the top of page.

2: the **editor page** offers the possibility to modify a page built by the logged in student

3: the **earth link** indicates that there is a URL available to look for other resources

4: the **blank page** permits to create a new page

5: the **dialog bull** offers access to posted comments

6: the **printing machine** enables the student to print the page in a easy to read on paper (different than the Internet one) format

7: the **bin** deletes the page (available according to the profile of the student

8: these **green links** are shortcuts showing the 5 last visited pages.

Figure 12: The control helps the student to gain time by accessing quickly to the main functionalities of the platform during a session on the platform

Like in any content management system, a wiki platform enables the student to edit the content in a simple way (Figure 13). Each cell of the edition page is modifiable, and offers the common tools available in the Web 2.0 Internet community. Thus, a student can choose the font, its size and color; insert a link, an image, a flash or video content, and bullets and so on. This is very common nowadays, but it contributes to a better appropriation of the content by students when they decide to modify any part of it on their own. This is useful in enhancing trust in the content, based on personalized, student by student, content management.

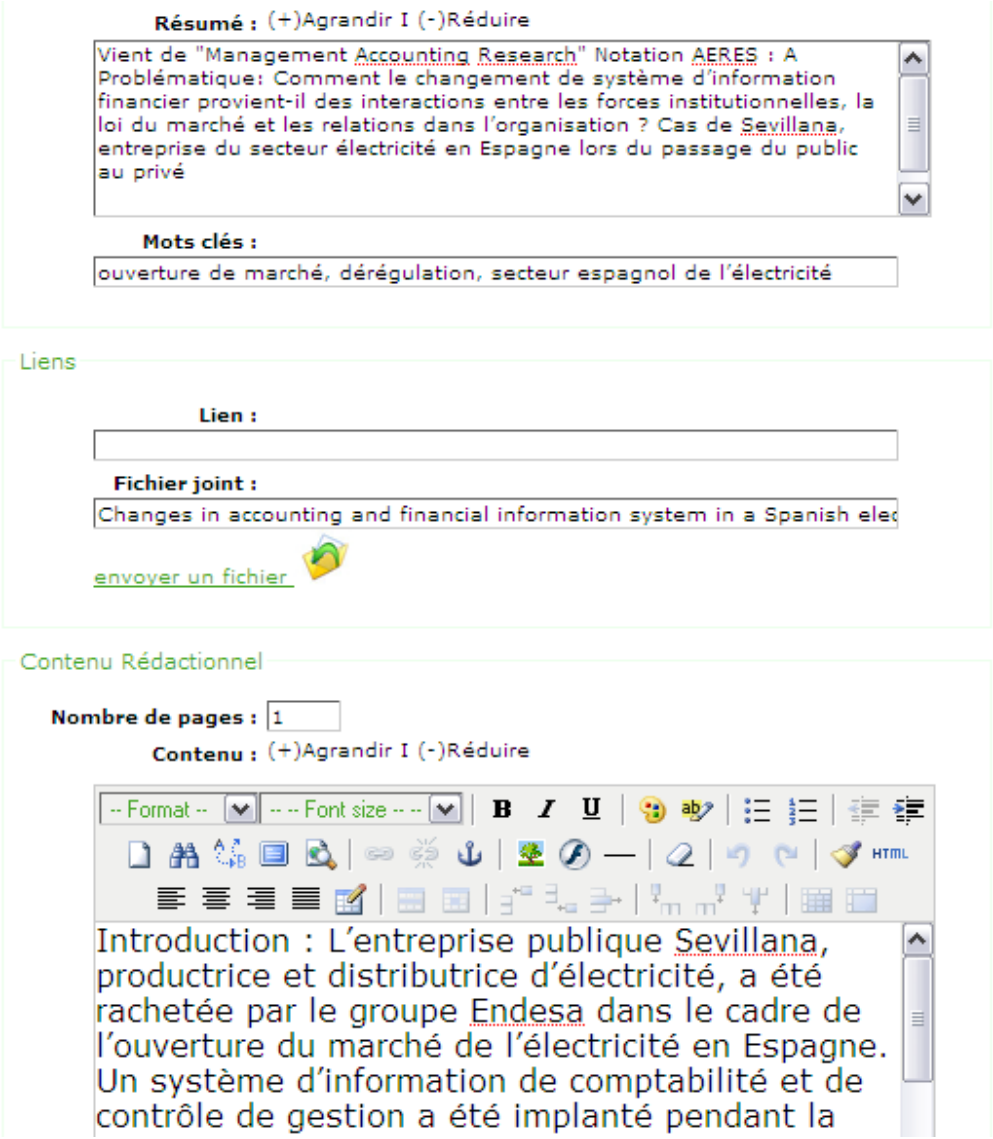


Figure 13: Each part of the content of each page of the e-learning platform can be modified easily thanks to a wiki system

In order to further augment student trust in the e-learning platform as well as in the e-learning content, the system shows when the page has been updated (Figure 14):

Figure 14: The use of connectors serves the content since it provides information such as the date it has been updated among other functionnalities

An e-learning platform, like a social network, can help students develop trust and stay loyal by offering them the possibility to comment what the professor says, or what their colleagues say. It obviously stimulates the dialog and enhances the trust towards the platform, especially if students are solicited to comment the content of pages. It also helps in memorizing the sequence of activities related to specific content. These comments can be described after the content of a lecture. An administration of these comments has not been useful for the last 6 years since students need to log in, being therefore identifiable by the professor (Figure 15).

Figure 15: Comments of the page enrich its content, and enhance trust towards the platform

Exams or whole class projects can also take part of the content of the e-learning platform, permitting the lecturer to follow the class progress in a single view. This feature facilitates not only students trust but also the educator trust in the e-learning platform. It also aids in keeping in memory the status of a project and the progress of students. It is then possible to think larger and work on major projects involving a whole group of students for example (Figure 16):

1	AliceBlue	Chavand Ghislain		Girotti Catherine		Grousset Caroline	
2	Aqua	Girotti Catherine		Grousset Caroline		Chavand Ghislain	
3	Azure	Grousset Caroline		Chavand Ghislain		Girotti Catherine	
4	Bisque	Correard Delphine		Balloy Léa		Marcombes Gabrielle	
5	BlanchedAlmond	Balloy Léa		Marcombes Gabrielle		Correard Delphine	
6	BlueViolet	Marcombes Gabrielle		Correard Delphine		Balloy Léa	
7	BurlyWood	Dominique Sylvain		Leroy Marine		Gregoire Fanny	
8	Chartreuse	Leroy Marine		Gregoire Fanny		Dominique Sylvain	
9	Coral	Gregoire Fanny		Dominique Sylvain		Leroy Marine	
10	Cornsilk	Deverge Emeline		Billiaert Virginie		Jospin_Colin Bertrand	

Figure 16: An entire class can work on a single page easily, for big projects for example

7. CONCLUSION

The design of an e-learning platform is of paramount importance for e-learning success, influencing learner interaction and behavior. This is in line with a large stream of research in information systems which have studied web design and have shown that web site quality and web site characteristics influence online consumer behavior (Torkzadeh and Dhillon, 2002; Singh *et al.*, 2005; Hampton-Sosa and Koufaris, 2005). Color constitutes an important variable for the design of e-learning platforms, as reported in information system studies, especially in usability, human-computer interaction and e-learning literature (Lee and Koubek, 2010; Coursaris *et al.*, 2008; Agarwal and Hedge 2008; McKracken *et al.*, 2004).

Memorization is a key goal of an e-learning system, ultimately aiming to make students learn and retain the educational content available. At the same time, trust in the e-learning platform is necessary in order for users to effectively adopt e-learning. The advanced usability of an e-learning platform offered by a careful selection of colors can enhance students trust in the e-

learning platform and the available content. Our conclusion follows Rhee, Moon and Choe (2005) results, showing that skilled students are generally more sensitive to interface consistency than novice students. The trust felt thanks to a proper assemblage of colors can enhance the appropriation of the e-learning platforms and help novices to become skilled, in order to perform more quickly and easily to exams. This study extends previous research on color in the context of e-learning and website design and contributes to existing information systems literature offering findings with important implications. Our study is the first, to our knowledge, that examines memorization in the context of e-learning. We introduce trust as a factor influencing memorization, contributing to the existing body of literature on antecedents of memorization in e-learning. We also examined two factors influencing memorization, color and trust.

The contribution of our study to information systems and more specifically e-learning literature mainly lies in providing findings on color that can inform and guide the design of websites in e-learning so that they are effective for attracting learner interest. By looking into trust, as a variable, which is an antecedent of retention and is influenced by color, our study further contributes in information systems. The research implications are most important for trust, as it is proposed as a new factor predicting memorization of online learners.

Our results on the effect of color on trust and memorization are not only relevant to e-learning web design but to web interface design in general and are also of value for research in web aesthetics, usability and human-computer interaction. Hence, our findings are relevant and important to information systems researchers, particularly to those active in the areas of usability, human-computer interaction and e-learning or the intersection of these areas.

These results must be related to the studies conducted by Silverstein (1987) who noticed that monochrome screens entailed more eyestrain and overall tiredness. Therefore, e-lecturers should be aware of this and choose carefully the colors that they will use on their site so as to adjust them to their target. They should also take into account the aesthetic and functional impact of those colors: their contrast facilitates finding information on a webpage. Learners recall information more easily when they had difficulty reading on an e-learning website.

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Key terms: color, memorization, trust, e-learning, interface, readability